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NASA TECH BRIEF

COPTRAN: A Method of Optimum Communication Systems Design

The problem:

To obtain optimum parametric values of a major communication system while minimizing the total cost of the system's components.

The solution:

The practical considerations and appropriate equations are combined in a single set of mathematical expressions that provides an optimum solution to the problem. These expressions may be summarized as follows: the probability of error for the transmission of data is expressed in terms of four basic parameters in the link equation; system cost is expressed in terms of the same parameters. Equations are set up by using a Lagrange multiplier, and partial derivatives are taken and set to zero. The solution of the equations gives the optimum values for the four basic parameters chosen to represent the link.

How it's done:

COPTRAN is a scheme by which a one-way space communication link can be designed in an optimum manner and, at the same time, weight and cost values for the component parts of the link can be determined. It is essentially a special computer language that has been developed for use as an interface with a previously developed computer program, Communication System Optimization Program with Stops (COPS). COPS provides optimum parametric values of a major communication link, but the user must have considerable knowledge of the computer. COPTRAN, on the other hand, enables the user to instruct the computer in familiar terms.

Physically, COPS is a subroutine in the program COPTRAN. The basic solution of the problem is obtained by determining the optimum values of the communication system being designed, while minimizing the total cost of the system's components. In this procedure, it is necessary to evaluate the communication-system burdens, cost of fabrication, weight, and electrical power requirements of each system component as a function of the major-systems parameters.

In addition to COPS, a subroutine called WORTH is utilized in COPTRAN. This routine enables the user to determine the worth, in dollars or pounds, of changing a parameter, extending a bound, or removing a constraint. In WORTH, up to four cases are run in which the variable of interest is used as a parameter. By this routine, four curves are produced that represent dollars or pounds versus bit rate. These curves indicate directly the cost of the proposed change. As an additional aid to the user in determining the worth, the differences of the curves are taken, and each difference is plotted, rather than presenting only the differences between the four curves plotted on the logarithmic scale.

Inputs required in processing COPTRAN are a tabulation of physical data, such as range, skyback-ground noise, wavelength, and transmissive losses; systems-burdens data, such as constants relating transmitting power to the weight of the transmitter, and the size of the antenna to its cost; and system-parameter contraints, such as the minimum, maximum, or fixed values for the major-systems parameters. The major-systems parameters are the diameter and gain of both the transmitting and receiving antennas, the transmitting power, and the receiver's field of view. The output of the computer is in the form of printed answers and graphical plots.

COPTRAN has been successfully applied in designing a direct-detection optical communication system

(continued overleaf)

in which thermal noise must be limited; a direct-detection optical communication system in which shot noise must be limited; a heterodyne-detection optical communication system; and a homodyne-detection radio communication system.

Notes:

1. The program of COPTRAN is written in FORTRAN IV for use on either the IBM 7094 or the GE 635. To obtain plotting output, the CalComp plotter is needed to provide the following plotting routines: plot, number, line, and symbol.
2. No further documentation is available. Inquiries may be directed to:
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Patent status:

No patent action is contemplated by NASA.

Source: L.S. Stokes, K.L. Brinkman, W.K. Pratt, and J.W. Weber of Hughes Aircraft Company under contract to Electronics Research Center (ERC-10273)